

Simulation Based Interpretation and Recent Trends on Performance Analysis on Automobile Radiator through Nano Particle Fluids

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ABSTRACT

The heat transfer system is of great importance in many commercial and domestic applications. Likewise, IC engine always maintained at the working temperature for good ex. The improper generation distribution of temperature affects the performance and reduces the efficiency of the engine hence to the vehicle/automobile. The performance of automobile Radiators can be substantially improved by a number of augmentation techniques. Heat transfer can be increased by active and passive flow control techniques or either with the incorporation of Nanofluids. As in order to remove the excess temperature, we need some cooling system in the automobile. The cooling system can be of two types Air and Water cooling system. Air cooling system is generally used in two-wheelers and airplanes. The air directly takes the heat from the surface of the engine through the fins available on them. In the water cooling system, a water jacket is provided around the engine which carries the heat of the engine and releases this heat to the atmosphere with the help of a component called a radiator. The radiator basically consists of the upper tank, lower tank, tubes, fins, thermostat, the inlet port and outlet port, pressure cap. In the present work, Simulation-Based Interpretation and Performance Analysis on Automobile Radiator through NanoParticle Fluids on modeled setup will be done trying to incorporate the condition of the automobile by using Nanoparticle fluids of Al₂O₃ and CuO. Water will also be taken to compare the performance of the Nanofluids. Results of numerous experimental and Ansys CFD solvers will be illustrated.

KEYWORDS: Automobile Radiator, Nano Particle Fluid, Simulation Analysis, Performance analysis, extended surfaces, cooling system

INTRODUCTION

Energy is a very important quantitative property that must be transferred before any system can perform work. The transfer of energy can be done by either work or heat. Heat is transferred from one system to another when there is a temperature difference between the two systems and which travels from high to low temperatures. The science that describes the means and rate in which thermal (heat) energy is transferred is known as heat transfer. Heat transfer applications are experienced in our daily life; the human body, for instance, is constantly emitting heat, and humans adjust their body temperature to suit environmental conditions using clothing. Heat transfer is also used in our buildings to regulate temperature and is necessary for cooking food, refrigeration and drying. It is also directly applied in radiators used widely in automobile. the present world urge firm and efficient working system. The working system should not do harm to the environment and also should not waste to energy. The accuracy of the system should be sufficient enough to meet the task assigned to it. Automobile is also one such system. Engine cooling almost

all automobiles inside the marketplace these days have a Form of heat exchanger called a radiator. The radiator is a component of the cooling machine of the engine as shown in Fig. 1. An automobile consists of a number of parts including wheels, glasses, body, cooling system engine figure no.2 etc. Every part should work with the other to give the optimum performance to the automobile. It is also very important to have protective as well as malfunction maintenance on the automobile which is for the safety of the environment and the system. In order to do maintenance of the cooling system, we need a radiator whose main function is to control the immoderate heat generated in engine. Just like the heart of the body, in close circuits shown in figure no. 3 a radiator does the same function in the automobile. It cools the hot coolants coming out of the engine with the help of tubes and fins present in the radiator. However, many factors are underlined in the development of the automotive industries among them as one point is the ability to rapid cooling of the products.

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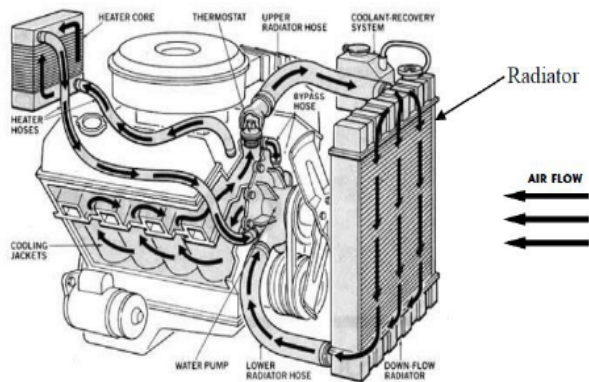


Figure no.1 Cooling system of a vehicle [7]



Figure no. 2 Parts of radiator

ABBREVIATIONS AND ACRONYMS

CFD	- computational fluid dynamics
IC	- internal combustion
Al_2O_3	- Aluminium oxide
TiO_2	- Titanium dioxide
LMTD	- logarithmic mean temperature difference
NTU	- Number of Transfer Units

LITERATURE REVIEW

This review paper has an emphasis on the purpose of simulating software/ CFD over the operation of heat exchanger over automobile radiator and outcomes in different performing parameter. Provide insight and understanding about the topic and related issues with Simulations performed in radiator to study the forced convective heat transfer behavior of coolant with and without nanoparticles.

Test performed by **Durgesh Kumar, et.al** [1] experimentally through forced convective heat transfer in an Al_2O_3 /water Nano fluid and compared to of pure water in an automobile radiator. Five different concentrations of Nano fluids in the range of 0–1.0 vol. % have been prepared by the addition of Al_2O_3 nanoparticles into the water. Results increase in the fluid circulation rate can improve the heat transfer performance.

The experimental study by **Paresh Machhar et.al** [2] has been conducted with forced convective heat transfer in water based Nano fluid compared to that of pure water in an automobile radiator. Five different concentrations of Nano fluids in the range of 0.1 - 1 vol. % will be prepared by the addition of TiO_2 nanoparticles into the water. The flow rate will be changed in the range of 2 - 5 l/min. additionally varying the temperature in the range of 37 - 49 °C. Results observed from investigators, application of nanofluid with low concentrations can enhance heat transfer efficiency up to 45% in comparison with pure water.

P Vijaya sagar et.al [3] has investigated that Radiators are used to transfer thermal energy from one medium to

another for the purpose of cooling. Radiators are used for cooling internal combustion engines, mainly in automobiles but also in piston-engine aircraft, railway locomotives, motorcycles, stationary generating plant. The radiator transfers the heat from the fluid inside to the air outside, thereby cooling the fluid, which in turn cools the engine.

Yeduru Jyothi et.al [4] has the designed a radiator without louver fins and with louver fins. The original radiator has no louver fins. The computational analysis tool ANSYS is used to perform a CFD analysis on radiator. The initial parameters are Inlet air velocity, Air Inlet temperature. Heat transfer analysis is done to analyze the heat transfer rate to determine the thermal flux. The material taken is Aluminum alloy 6061 for thermal analysis. In this research they found that while decreasing the tube diameter, then the tube side outlet temperature will be increasing in the radiator 343.6 to 356.1

Omprakash Pal et.al [5] designed and simulated radiator cover or under-hood by different methodology and different tools to reduce hot air recirculation in radiator cover by its better design options and IRFM sealing around radiator in new vehicle for air flow optimization to increase radiator efficiency by done using HYPERMESH 11. Analysis was done for minimum speed at maximum power and torque conditions by CFD solver ACUSOLVE 1.8a. They have considered Forced convection was for cold simulation for baseline model to analyses flow and velocity distribution and results obtained were modified to increase flow characteristic and heat dissipations. Research resulted in improved flow, reduced recirculation and elimination of leakage around them. Average velocity of air and outlet temperature of coolant both increased as compared to baseline model and above 80% correlation was obtained against test data by CFD analysis.

Chavan D.K. et.al [6] designed and developed a radiator which proposed to have circular radiator core where all conventional are in either square or rectangle shaped which have following disadvantages; fan deliver air flow in circular shape so its air distribution is not uniform over the entire core less at corners and almost zero at center along axial direction. For CFD analysis, model of radiator and the fan was made in CATIA V5 and then exported to CFD analysis software. With the help of these data obtained LMTD and NTU method effectiveness of radiator was calculated assuming cross flow with both fluids unmixed. Result concludes: compact design, less material hence less cost, more efficient, less power consumed by fan. Nevertheless this model was having some limitations like bending of tubes in circular shape which increase loss of head in flow, inserting of fins in circular shaped tubes is itself a problem and dies needed to be manufactured for circular shaped radiator which increase its production cost.

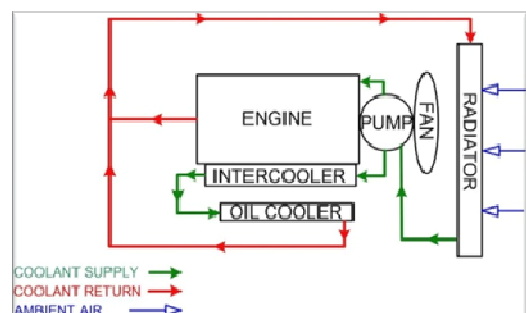


Figure no.3 circuit diagram of circulation of coolant [8]

Preliminary all simulation analysis of radiator modelled by researchers is performed with water and numerous coolant under different parameters, to check whether the solution is converging. Then analysis is done by changing the coolant to nanofluid under same parameters. The simulation results obtained show reasonable variation in the temperature as expected.

CONCLUSION

- CFD analysis has reduced the cost, time in design and development of radiator as compared to conventional methods.
- It also reduces the need of prototype during design process while we do iterations to get optimized design.
- By changing nanofluid and their concentrations we can see how different volume percentage of nanoparticles performs in the radiator.

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